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# THE SCIENTIFIC WORK OF PROFESSOR J. A. SCHOUTEN
(28. 8. 1883 — 20. 1. 1971)

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## INTRODUCTION

On January 20, 1971, died Professor J.A. Schouten after eighty seven and half years of an unusual useful life, in this forty four years devoted to creative scientific work. It can be said without exaggeration that Schouten had opened and closed an epoch in differential geometry. He had opened it because his paper [18] written in 1918 together with a paper of T.Levi-Civite in 1917 initiated a great new and fertile term in differential geometry. He closed it because his last four papers (See [211], [213], [214]) were linked with new problems connected with global geometry on manifolds and with differential topology. Schouten entered the field of differential geometry as an outsider since he had been educated to become an electrical engineer who accidentally took interest in the just created relativity theory. He was fascinated by it and he decided to devote his research to differential geometry which is indispensable to general relativity theory. He retired from active scientific life in 1958 when he had realized that he was no more able to do creative work due to a serious illness. He retired in a rather unusual way: on some day he made a decision to sever his connections with mathematics and he sent his ample library to the Mathematical Center in Amsterdam. This decision turned out to be discontinuous.

An exhaustive discusion of Professor Schouten s works requires a scrupulous collection of the material and will be

postponed to a second part of this article which will appear later. In this part I would like to present only his bibliography with a short curriculum vitae. I will also classify his papers and briefly discuss his scientific contributions.

## THE LIFE OF PROFESSOR J.A.SCHOUTEN

Johann Arnoldus Schouten was born on August 28, 1883, at Nieuwer Amstel, on the outskirts of Amsterdam. After graduating from high school he started technical study in Delft at the Polytechnic School (for a long time it was the only polytechnic in Holland, which provided excellent engineers especially to the Dutch India). In 1908 he finished the department of electrical engineering with an M.Sc. degree. He accomplished his professional practice in Rotterdam and Berlin. However, scientific interests took over the mind of the young engineer. He got interested in the special relativity theory of Einstein and he noticed instantly that without increasing his knowledge of geometry and physics he would not be able to understand thoroughly this new field which fascinated him. As the first result of this self-study (in mathematics he always remained a self-taught person, he has never finished a regular mathematical study) he wrote a long paper [1] about the foundations of vector and affinor analysis. This paper was introduced by Felix Klein who wrote a favourable preface. On the basis of this paper he was awarded a Ph.D. in mathematics from the Polytechnic in Delft. Felix Klein himself probably did not imagine that twelve years later (after the death of Klein) the young doctor would write a paper in which the famous classification principle of Klein would be significantly generalized.

From 1914 till 1943 Schouten held the position of a professor of mathematics at the Delft Polytechnic. He was the head of the chair of Pure and Applied Mathematics and Mechanics. He lectured more mechanics than mathematics. In 1943 he was forced by the German occupation authorities to leave the

polytechnic and he moved to a country home which he previously built in a small village Epe. After the war he returned to Amsterdam where he took part in organizing the newly created Mathematical Center. He became a member of this Center in 1946. For five years (1948-1953) he was simultaneously a professor of the Amsterdam University. In 1931 he spent one year in the United States as a visiting professor. In 1934 he was invited by Professor Kagan to Moscow where he spent six weeks organizing an international conference devoted to applications of tensor calculus. In 1935 he visited Cracow where he delivered a talk on spinor theory [132]. In 1933 he was elected a member of the Royal Academy of Sciences in Amsterdam. In 1954 he presided the International Mathematical Congress in Amsterdam. As one of the chief organizers of this congress he was the life and soul of it. In 1957 he suffered a heart attack which ended his scientific career. As a matter of fact he held yet for a year till 1958 the position of the president of the Mathematical Center in Amsterdam but he ceased any scientific activity and, as I mentioned already, he completely retired from mathematical life although his spirit was still strong enough. At the end of 1970 he suffered a strong attack of diabetes (caused by a developing cancer) from which he did not recover. He died not suffering much on January 20, 1971.

## AN OUTLINE OF SCIENTIFIC ACTIVITY OF J.A.SCHOUTEN

The fact that Schouten's interest in geometry had been originated by relativity theory influenced strongly his whole scientific carrer. The number of papers which are connected with physics or entirely belong to physics amounts to 47, that is 24% of the total. But on the other hand there are papers that belong neither to physics nor to geometry despite the fact that they were inspired by physics or geometry. There are also papers belonging to algebra, to differential equations and to the theory of transformatons groups.

When Schouten began his scientific work, two distinguished geometricians, O.Veblen and L.P.Eisenhart, were working in U.S.A., and others like E.Cartan, T.Levi-Civita and W.Blaschke, to mention only the most distinguished names, were active elsewhere in Europe. However, no one of them became an example for Schouten. He found from the very beginning his own way, although he had some common (but independent) ideas with Levi-Civita and with Cartan he had two joint papers. And this independence of research activity is the most important feature of his great individuality. The second feature was the ability for inspiring his pupils to creative work, which in the first stage consisted in collaboration with the master. Among his followers and pupils one can mention the following names (in alphabetical order): D.J.Struik (Professor Emeritus, new living in Belmont, U.S.A.), D. van Dantzig (the late professor from Delft and from Mathematical Center in Amsterdam), V.Hlavatý (the late professor from Prague, later in Bloomington, U.S.A.), E.R. van Kampen (who emigrated from Delft to the U.S.A. and died untimely), writing these word S.Gołąb, J.Haantjes (the late professor from Leid), van der Kulk (he emigrated to the Unites States and worked in IBM, Owergo N.Y.), H.Dorgelo, K. Yano (a distinguished Japanish geometricien), and A.Nijenhuis (presently professor in the Unites States). As we see from the above list, Schouten survived some of his pupils. There are many geometricians in Soviet Union and some other countries who may consider themselves his indirect pupils. The number of joint papers of Schouten with other mathematicians amounts to 73. This also indicates on a very strong individuality of Schouten. The third feature of his individuality is the number of domains in which he worked. As the late Italian mathematician R.Cacciopoli said once, the true mathematican changes every two years his research field. If we even consider Cacciopoli's opinion as strongly exagerating, we have to admit that with respect to Schouten it confirms quite exactly. The fourth feature of scientific activity of Schouten is his ability to far-reaching generalizations marked in most of his papers. In 1930 L.Berwald told me that he was astonished by

Schouten's ability of "seeing" some non-trivial facts in spaces of arbitrary high dimensions. As the fifth quite rarely met feature one can mention his passion for reforming the mathematical symbolism. It is certain that the n-dimensional geometry could not have been developed had it not borrowed the adequate stenographic symbolism from tensor calculus. As a matter of fact the pioneers of these ideas were Ricci, Levi-Civita and Einstein, but only Schouten developed this technique to its perfect shape. Today it is easy to write that (cited after K.Maurin) "the works of Ricci and Christoffel, and later the heroic time of general relativity theory caused the full developement of the so-called tensor analysis with its orgy of indices and connections perfected by Schouten and his school", but one should not forget that for a very long time it was necessary to operate with coordinate systems and an invariant notation without a plethora of indices was unthinkable. Only the developement of the theory of fiber spaces allowed to obtain an invariant notation independent of a coordinate system (i.e. independent of an atlas as is said now) which reduced considerably the number of indices. It is to be atributed to Schouten's merits that he first attempt (with D.J.Struik) to represent the geometrical content without indices ("Direkte Methode"), but non-geometricians in general do not know this since Schouten later abandoned this method developing instead another called "Kernindexmethode" which turned out to be connected with indices after all. The reforming passion, as far as the symbolism is involved had never left Schouten; probably it was a relic of his technical education. He always claimed that a mathematical symbol had to be possibly simple, but at the some time it had to reflect its full content. As far as the simplicity of proofs were concerned Schouten was so extreme that he said once half-seriously that: "this cannot be true because this is too complicated". The accuracy of proofs in Schouten's works was rather median (similarly as in Cartan's works) but nevertheless admirable if one takes into account his technical background. An extraordinary intuition permitted him to avoid errors in his reasonings. One can

ask what were his didactic abilities. His lectures were very clear and lively, he spoke rather fast but understandable. On the other hand his textbooks and papers were written rather heavily and they require from the reader a great effort to follow the main idea. His scientific research were well organized, in a typical engineering way. Because he worked always on several simultanous problems he kept tract of them with the help of double numeration of pages (the running number of the paper and the running number or the actural work), independently of the fact that the pages of the works were always segregate into seperate covers. He also kept a seperate index of titles with corresponding numbers and his file of reprints of related papers was so organized that he could find very fast the necessary work.

I do not know what were his other fields of interest besides mathematics and how much time he devoted to research and to studying literature. He made an impression of an extremaly well organized man. He did not belong to absent-minded persons, but on one occasion I found out that he did not remember his own scientific results. Twice a week we were going together by train to Leid (being a professor in Delft he lectured in Leid as a privatdozent). During one common travel Schouten formulated a problem asking me to solve it. After several days I succeeded in solving it. Schouten told me to prepare a publication about it, but not long later I found a solution of this problem in one of his earlier publications [69].

Among Schouten's publications there are, beside research papers, textbooks, mimeographed texts, monographs, as well as several articles of metamathematical or philosophical character (for example, an opening address after his nomination on the chair at the Polytechnic in Delft, and his inaugural address on the occassion of his election to the presidency of the Polytechnic, and an inaugural address on the occasion of his election to the presidency of Mathematical Center in Amsterdam). These articles are unfortunately published only in Dutch and due to this fact they are not widely known although they contain deep thoughts and philospohical reflections. As an

example let me mention the presidential address in 1938 entitled "Geometry and Experiment" in which he predicted in a most exact way the possibility of release of the nuclear energy in such proportions which have found 6 years later their realization in the atom bomb. It is probably the only published scientific prediction concerning physics formulated by a gometrician and not by a profesional physicist.

Editors' note: This biography ended with a list of the scientific publications of J.A. Schouten. It is not reproduced here, because a revised and extended version of his bibliography is printed at the end of this book. Below we merely list those publications which are referred to in the preceding text.

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